INTRODUCTION

The Taupo Volcanic Zone (TVZ), New Zealand, is one of the most productive areas globally of explosive silicic volcanism in the early Pleistocene through the Holocene. The TVZ is a continuation of the Havre Trough, the subduction-related back-arc spreading system of the Kermadec Arc, through continental crust of the North Island of New Zealand (fig. 1). Early and middle Pleistocene products of TVZ volcanism are generally concealed within the interior of the zone owing to burial beneath voluminous younger volcanic products, accentuated by subsidence through normal faulting and caldera collapse. Accordingly, few areas are available to study the early Pleistocene to Holocene proximal volcanic, magmatic, and tectonic development of the TVZ. An exception is the southeast margin of the TVZ where two parallel, northeast-trending fault blocks expose mainly middle Pleistocene volcanic products consisting chiefly of ignimbrites, some welded and spectacularly cliff

forming. On the southeast is the Paeroa Fault block (fig. 2) and adjacent to the northwest is the Te Weta Fault block. Both fault blocks are exposed for ~25 km in a northeasterly direction, parallel to the overall trend of the TVZ, and each is 3 to 10 km across. Northeast-striking normal faults with down-to-the-northwest displacements bound both fault blocks along their northwest margins. The topographically highest parts of the fault blocks are within their centers, attaining 979 m above sea level (at Paeroa) and 627 m above sea level (at Te Weta), and they each descend in elevation to the northeast and southwest to as low as 300 m above sea level. The Paeroa Fault block is a horst structure that divides

the Taupo-Reporoa Basin to the east from the Taupo Fault Belt to the west (figs. 2, 3). The Te Weta Fault block is part of the Taupo Fault Belt and appears to have undergone greater erosional dissection and has fewer exposed contacts. The Taupo-Reporoa Basin is situated along the eastern part of the map area, and its northernmost part underwent collapse to form the approximately 12-km-diameter Reporoa Caldera (fig. 3). This caldera is the source of ignimbrite sheets and a coeval air-fall tephra of the Kaingaroa Formation (unit kaf) and is topographically level except for small hills made of rhyolite lava domes that pierce the surface at Deer Hill (unit rdh), Kairuru (unit rka), and Pukekahu (unit rpu).

As the largest exposed fault block within the TVZ, the Paeroa Fault block and surrounding topographically high standing areas encompass Quaternary lavas, ignimbrites, and sedimentary deposits that are otherwise buried throughout much of the Taupo-Reporoa Basin to the east. Previous mapping of this general area was undertaken in the 1950s and 1960s by Grindley (1959, 1960, 1961) and Healy and others (1964) and compiled as part of the 1:250,000-scale map by Leonard and others (2010). This map displays the volcanic and sedimentary geology of ~430 km² of the Paeroa Fault block and the adjacent Te Weta Fault block, within the Taupo Fault Belt to the west, and the northern Taupo-Reporoa Basin and Reporoa Caldera to the east (figs. 2, 3). This map divides the faulted early and middle Pleistocene volcanic products into three groups that are overlain and onlapped by generally undisrupted late Pleistocene and Holocene surficial volcanic and sedimentary deposits. In order of oldest to youngest, these are the Reporoa Group, followed by the Whakamaru Group and its accompanying Paeroa Subgroup, and finally the Huka Group. Surficial deposits are any young valley-filling volcanic (units tag, tpf) or sedimentary deposits (units tga, tpa).

The vast majority of volcanic products mapped in the area consists of middle Pleistocene rhyolitic ignimbrites and air-fall tephras (units kaf, maf, mpf, ohf, paf, rmi, tkf, twf, waf, whq) and lava domes (units rdh, rh3, rka, rng, rpu, rt8). Basalts, andesites, and dacites are subordinate to rhyolites and were emplaced explosively during small-volume phreatomagmatic eruptions (units abf, ama) or extruded effusively as lava domes (unit dma). At least one extensive hydrothermal-eruption breccia is exposed (unit hbp), and lacustrine and fluvial sediments (units hga, tga, tpa) indicate that paleolake systems

The map area encompasses ~430 km², consisting mainly of the two high-standing ridges of the Paeroa and Te Weta Fault blocks that are separated by the northward-draining valley of Mangatete Stream. The map area is limited on the south by the Waikato River, on the west by Lake Ohakuri, and on the east by the low, exposure-poor area of Reporoa Caldera. The north limit of the map area is based on the loss of widespread exposures of middle Pleistocene volcanic products owing to concealment beneath late Pleistocene products from the Okataina Volcanic Center (mainly unit eff). Settlements include the small villages of Reporoa and Waiotapu in the eastern and northeastern map area, which is crossed by Highway 5. The remainder of the map area is sparsely populated, with much of the area owned by local ranchers and used for the grazing of sheep and cattle. The more vegetated areas, including the topographically highest regions, are overseen by the (New Zealand) Department of Conservation. Despite being sparsely populated, the numerous ranches in the area provide abundant manmade structures and both paved and dirt roads facilitating access. Visitors should obtain appropriate permission from land owners and (or) managers prior to venturing onto private property and should exercise the proper etiquette for crossing fences and gates to avoid the destruction and (or) disruption of day-to-day activities. Few maintained hiking trails exist. However, the lack of vegetation and presence of sheep and (or) cattle trails throughout the map area make hiking to outcrops in areas of level topography straightforward and easy. Extensive

faulting and the easily erodible nature of unwelded to moderately welded

potential outcrops before undertaking field work.

AUSTRALIAN

PLATE

ignimbrites are reflected by the topographic roughness of both the Paeroa and Te

Weta Fault blocks. Changes in topography are dramatic in places (for example,

the Paeroa Fault scarp), where elevation changes of ~600 m can occur in <1 km

distance. Additionally, where present, vegetation can be dense and create a near

impenetrable barrier. Therefore, prior planning should be used to select routes to

tectonically higher (upper)

Convergence direction

Coromandel Volcanic Zone

Taupo Volcanic Zone

Northland Arc

Figure 1. National Institute of Water and Atmosphere (NIWA) 250-m gridded bathymetric data

Coromandel Volcanic Zone to its current location in the Taupo Volcanic Zone (beginning ~2 Ma).

Figure 3. Photograph looking south-southwest along the Paeroa Fault zone with both the Paeroa

Fault block and Te Weta Fault block visible. The greatest relief on the Paeroa Fault scarp is >600

Basin is present to the east (left-hand side of the photo), whereas the Taupo Fault Belt is present

dotted line with teeth pointing towards its collapsed portion. Photograph by Dougal Townsend of

m in the middle of the fault block. Reporoa Caldera in the northern part of the Taupo-Reporoa

to the west (right-hand side of the photo) of the Paeroa Fault zone. Approximate traces of the

downdropped blocks. Approximate location of the Reporoa Caldera boundary is shown as a

Paeroa Fault zone and Ngapouri Fault zone are shown as solid lines with teeth on their

GNS Science, 2013.

from 2016. The main tectonic features of the Hikurangi subduction zone controlling arc-related

volcanism on the North Island of New Zealand are shown. Arc volcanism on the North Island

initiated in the Northland Arc by >25 Ma, and has migrated south with slab rollback to the

GEOLOGIC SETTING

The North Island of New Zealand exposes a remarkable variety of volcanic and sedimentary deposits formed in response to late Cenozoic subduction along the Pacific and Australian plates (fig. 1). These products of plate convergence were emplaced atop a substrate of mainly Mesozoic and early Cenozoic deep marine sedimentary rocks. Since ~16 Ma, northwest-directed subduction of the Pacific plate beneath the Australian plate, and associated slab rollback, are proposed as the major controls on the migration of volcanic centers (Seebeck and others, 2014). Despite uncertainties about subduction orientation prior to ~16 Ma, basaltic to andesitic volcanism was ongoing by at least the late Oligocene (~25 Ma) in the Northland Arc of northernmost New Zealand (fig. 1). Northland Arc volcanism overlapped slightly with, and was followed by, andesitic and rhyolitic volcanism within the Coromandel Volcanic Zone, as well as in the offshore Tasman Sea, between 18 to 2 Ma. Andesitic volcanism within the present-day TVZ (fig. 2) started at ~2 Ma, with large-volume rhyolitic eruptions proposed to have initiated in the 125-km-long by 60-km-wide central segment by \sim 1.9 Ma (Eastwood and others, 2013).

The TVZ is subdivided into northern and southern segments that experience andesitic cone-building volcanism, separated geographically by a 125-km-long by 60-km-wide central segment that is noteworthy for the intensity of its caldera-related rhyolitic volcanism (fig. 2). The rifting arc of the central segment of the TVZ is regarded as the most active silicic volcanic system on Earth, having erupted caldera-related ignimbrites at an average rate of 3.8 km³/kyr since ~1.6 Ma (Wilson and others, 2009). This central segment has erupted >10,000 km³ of silicic magma during at least 25 caldera-related, and numerous smaller-volume, eruptions (Houghton and others, 1995; Wilson and others, 2009). The modern loci of silicic volcanism are the Okataina and Taupo Volcanic Centers (fig. 2) at the northern and southern ends of the central segment of the TVZ, respectively (Wilson and others, 2009; Cole

Caldera collapse, secular rifting (Rowland and Sibson, 2001), and associated volcano-tectonic processes (Gravley and others, 2007; Rowland and others, 2010; Downs and others, 2014a,b) have interacted in such a way that basins (in other words, grabens and calderas) and fault blocks are present throughout the TVZ (fig. 2). The most noticeable basins are situated between the active Taupo and Okataina Volcanic Centers, as the Taupo Fault Belt and Taupo-Reporoa Basin (figs. 2, 3). Both of these basins are subsiding at 3 to 4 mm/yr (Manville, 2001; Villamor and Berryman, 2001) and extending at 10 to 12 mm/yr (Wallace and others, 2004). Between these basins, rising >600 m above the surrounding landscape, is the Paeroa Fault block (fig. 3). This fault block is the surface manifestation of a horst that separates the Taupo Fault Belt and Taupo-Reporoa Basin (Wilson and others, 2010).

PAEROA FAULT BLOCK

The Paeroa Fault block is the largest exposed horst structure within the TVZ. As defined here, the Paeroa Fault block extends for ~25 km, from the Waikato River northeast to the Maungaongaonga dacite dome (unit dma), and it ranges from ~ 10 km wide in the south to ~ 3 km wide near its north end. This fault block is bounded along its northwest margin by the Paeroa Fault zone, which displays a dramatic fault scarp that exposes >600 m thickness of rhyolitic ignimbrites at its greatest height. The Paeroa Fault zone also trends southwest to northeast on an azimuth of 040 to 050° over a distance of ~30 km. It has undergone pure normal dip-slip movement and has a calculated slip rate of 1.1 to 1.7 mm/yr (Berryman and others, 2008). The eastern part of the Paeroa Fault block has been truncated and is now bounded by the Reporoa Caldera, which collapsed in response to eruption of the Kaingaroa Formation (unit kaf). Models for Paeroa Fault block development include (1) rapid magma-driven structural resurgence following caldera collapse (Healy, 1964), (2) gradual tectonic tilting as a result of normal dip-slip movement along the Paeroa Fault zone (Berryman and others, 2008), (3) primary ignimbrite fan deposition, or (4) a combination of

ERUPTIVE HISTORY Volcanic deposits within the central segment of the TVZ have been allocated into three groups that are exposed within the Paeroa Fault block. The oldest is the Reporoa Group (Gravley and others, 2006), which is defined as lavas, ignimbrites, and volcaniclastic and sedimentary deposits emplaced from inception of the TVZ (~2 Ma) to emplacement of the Whakamaru Group ignimbrites. Overlying the Reporoa Group is the Whakamaru Group, which consists of >2,500 km³ of crystal-rich ignimbrites and a coeval air-fall tephra (Brown and others, 1998) emplaced during two distinct eruptive episodes at 349±2 and 339±2 ka (Downs and others, 2014b). The youngest is the Huka Group (Grindley, 1965), which consists of lavas, ignimbrites, and volcaniclastic and sedimentary deposits between Whakamaru Group and surficial deposits. Grindley (1965) subdivided the Huka Group into ignimbrites of the Waiora Formation (not exposed in the map area), which are overlain by lacustrine sediments of the Huka Falls Formation (not exposed in the map area). We assign lacustrine and fluvial sediments throughout the Paeroa and Te Weta Fault blocks to the Huka Group Alluvium (unit hga) on the basis of their middle Pleistocene stratigraphic positions, whereas ignimbrites on the map sheet are named using the nomenclature of Leonard and others (2010).

REPOROA GROUP

Units assigned to the Reporoa Group are only sparsely exposed within the Paeroa Fault block. This group is represented by two rhyolite lava domes (units rng, rt8) and the caldera-related rhyolitic Waiotapu Formation ignimbrite (unit waf) within the northern part of the fault block. Both Grindley and others (1994) and Wood (1994) distinguished and mapped additional ignimbrites and volcaniclastic deposits of this age within the northern Paeroa Fault block, although we visited the same sites and assigned these volcanic deposits to different units.

WHAKAMARU GROUP

The Whakamaru Group is composed of the most voluminous (>2,500 km³) caldera-related ignimbrite sequence from the central segment of the TVZ. It is divided into an early group erupted at 349±2 ka (collectively designated as unit whg) and the Te Kopia (unit tkf), Te Weta (unit twf), and Paeroa (unit paf) ignimbrites, in ascending stratigraphic order, that erupted later at 339±2 ka (Brown and others, 1998; Downs and others, 2014b). The Te Kopia (unit tkf), Te Weta (unit twf), and Paeroa (unit paf) ignimbrites are all formations that constitute the Paeroa Subgroup and are the only Whakamaru Group exposed within the Paeroa and Te Weta Fault blocks. These ignimbrites have a cumulative thickness of >600 m at the greatest height of the Paeroa Fault scarp, and the base of the subgroup is not exposed. Only a few locations within the northern part of the Paeroa Fault block expose overlying ignimbrite (unit kaf) and lacustrine sediments (unit hga) of the Huka Group.

The Paeroa Subgroup ignimbrites all have similar lithology, petrography, geochemistry, and ages. An absence of erosional unconformities and paleosols within the Paeroa Subgroup indicates that there were no significant time breaks between eruptions. Paeroa Subgroup ignimbrites erupted from a linear vent zone geographically coincident with the Paeroa Fault zone, based on the thickness variations in the ignimbrites and the distribution and sizes of lithic clasts in coignimbrite lag breccias (Downs and others, 2014b).

HUKA GROUP

Units assigned to the Huka Group are primarily exposed within the southern half of the Paeroa Fault block, the southern and northwestern part of the Te Weta Fault block, and in a few patches within the northern part of the Paeroa Fault block. Most of the volcanic products assigned to the Huka Group use the previous naming scheme of Leonard and others (2010); a few informal unit names identify geographic locations of lava domes and ignimbrites. A sequence of interbedded ignimbrites, air-fall tephras, and paleosols termed Onuku Breccia by Nairn (2002) and incorporated into the Maroa Group by Leonard and others (2010) has been identified within the northern part of the Paeroa Fault block. A small patch of a similar sequence has also been identified within the southern part of the Paeroa Fault block. Due to poor and limited exposures, these stratigraphic sequences have not been investigated in detail and are therefore assigned to a unit of undivided Quaternary volcanic (unit Qvo)

One of the great benefits of the preservation of Huka Group volcanic products within the Paeroa Fault block is that it enables investigating links between volcanism and geomorphology. Several of the caldera-related ignimbrites within the Paeroa Fault block fall into the time interval that Gravley and others (2016) term an ignimbrite flare-up, which was a period of intense caldera-related volcanism that initiated with eruption of the Whakamaru Group (unit whg) at 349±2 ka and ended with eruption of the 246±5 ka Ohakuri Formation (unit ohf). Gravley and others (2016) originally proposed that the flare-up ended at ~230 ka with eruption of the Kaingaroa Formation (unit kaf), based on an ⁴⁰Ar/³⁹Ar age from Houghton and others (1995). However, an ⁴⁰Ar/³⁹Ar age from Downs and others (2014a) and a new ⁴⁰Ar/³⁹Ar age presented here indicate that the Kaingaroa Formation (unit kaf) erupted at 299±3 ka. In total, >3,000 km³ of magma was erupted as at least eight caldera-related ignimbrites (units kaf, maf, mpf, ohf, paf, tkf, twf, whg, and the unexposed units of the Chimp and Pokai Formations), of which most are exposed within the Paeroa and Te Weta Fault blocks. Many geomorphic features within the central segment of the TVZ, such as the Taupo Fault Belt, Taupo-Reporoa Basin, and ignimbrite ages and basin reconstructions.

immediately younger, horizontally bedded Huka Group Alluvium lacustrine We infer that Paeroa Subgroup (units paf, tkf, twf) exposed along the Paeroa scarp (Downs and others, 2014a). Gravley and others (2007) present evidence that migration of a shallow magma reservoir caused rapid subsidence (>300 m) in the Taupo Fault Belt during, or shortly following, eruptions that deposited the Ohakuri Formation (unit ohf) and Mamaku Plateau Formation (unit mpf) during collapses of the

Caldera demonstrate that the caldera collapse structure filled rapidly (mostly by ~265 ka) with little subsequent subsidence of the northern part of the Taupo-Reporoa Basin (Downs and others, 2014a). Thus, despite the calculated extension and subsidence rates for the past ~45 ka (Manville, 2001; Villamor and Berryman, 2001; Wallace and others, 2004), most present-day geomorphic

features within the central segment of the TVZ appear to have formed during the middle Pleistocene ignimbrite flare-up, and younger deformation has

bracketed by rhyolitic air-fall tephras that were emplaced at ~45 and 30 ka (Leonard and others, 2010).

Paeroa Fault block, developed during this flare-up time interval on the basis of Downs and others (2014b) proposed that the geographic distribution of the 339±2 ka Paeroa Subgroup ignimbrites (units paf, tkf, twf) represents a primary zone from which these ignimbrites erupted. In addition, syneruptive uplift of the Paeroa Fault block and subsidence of the adjacent Te Weta Fault block occurred as a result of movement of magma through and out of a shallow reservoir during these eruptions (Healy, 1964). Evidence in support of this interpretation includes sediments (unit hga) within the southern part of the Paeroa Fault block that are juxtaposed with, but absent over, exposed Paeroa Subgroup units (paf, tkf, twf). Fault scarp has remained a topographic high since eruption. A similar argument has been made for the southern part of the Paeroa Fault zone and its relation to the 246±5 ka Ohakuri Formation (unit ohf) exposed along that part of the fault

Ohakuri and Rotorua Calderas, respectively (fig. 2). Subsidence also occurred in the Taupo Fault Belt as a direct result of earlier eruptions associated with the Kapenga Caldera Complex (fig. 2). To the east, ages of exposed intracaldera rhyolite lava domes (units rdh, rka, rpu) infilling the 299±3-ka Reporoa

Both long- and short-lived lake systems commonly form in extensional arc settings, such as the central segment of the TVZ. Lacustrine sediments >10 m thick of the Huka Group Alluvium (unit haa) are exposed within the northern part of the Paeroa Fault block between ignimbrites dated at 339±2 ka (units paf, tkf, twf) and 322±7 ka (unit maf). In the southern part of the Paeroa Fault block, lacustrine sediments were deposited alongside, and interbedded with, ignimbrites from at least 299±3 ka (unit kaf) to the youngest Mihi Breccia

ignimbrite (unit rmi) dated at 239±3 ka, yielding a >60 kyr paleolake. Mihi Breccia ignimbrites (unit rmi) are interbedded with post-Kaingaroa Formation (unit kaf) lacustrine sediments of the Huka Group Alluvium (unit hga). Characteristics of the Mihi Breccia (unit rmi), such as stratigraphic position, abundant lacustrine rip-up clasts, prismatically jointed margins on juvenile clasts, and absence of thermally induced oxidation colors, welding, fiamme, and eutaxitic textures, reflect emplacement into and, based on the abundance and extent of lacustrine sediments, eruption through a paleolake. It is apparent from the high-energy lithofacies (from sedimentary structures) in lacustrine sediments (unit hga) interbedded with Mihi Breccia (unit rmi) that the water column was deeper than 2 to 3 m below the wave base at times. Downs and others (2014a) and Downs (2016) proposed that the dam creating the paleolake was the result of a long-extant (>10 kyr) rhyolite lava dome that blocked the Waikato River where it exited the central segment of the TVZ at the Ongaroto Gorge.

SURFICIAL DEPOSITS

Due to high stratigraphic positions and a lack of appreciable structural disruption, young ignimbrites (unit tpf), volcaniclastic sediments (units abf, most of tag), alluvial sediments (units tga, tpa), and colluvium (unit col) are classified as surficial deposits. Primary unwelded ignimbrite of the Taupo Pumice Formation (unit tpf) is widespread and forms a veneer over most of the landscape of the map area, but it is only shown in areas where it has ponded in valleys and basins to thicknesses sufficient to obscure underlying units. The sedimentary deposits designated as surficial are also restricted to low-lying areas. Several of the deposits are alluvial, having been reworked from prior eruptive products. The Taupo Group Alluvium (unit tga) consists of sediments of reworked primary volcanic products emplaced between the Oruanui Formation eruption at 25.4±0.2 ka (part of unit tag; age from Vandergoes and others, 2013) up to, but not including, the Taupo Pumice Formation (unit tpf) eruption at 232±5 CE (Hogg and others, 2012). The Hinuera Formation, encompassed by the Taupo Group Alluvium (unit tga), consists of an alluvial deposit that has been directly reworked from Oruanui Formation ignimbrite (Manville, and Wilson, 2004). Similarly, the Taupo Pumice Alluvium (unit tpa) consists of reworked volcaniclastic sediments derived from the ignimbrite mapped as the Taupo Pumice Formation (unit tpf). A single, basaltic scoria and breccia is part of the surficial deposits. This is called the Akatarewa Basalt Formation (unit abf), which is located at the south end of the Paeroa Fault block. This basalt has not been directly dated but is

[All units are arranged chronologically within their designated groups (surficial deposits, Huka Group, Whakamaru Group and its associated Paeroa Subgroup, and Reporoa Group) and separated by solid blue lines. Eruption ages where known, are provided to the left of unit boxes (see Description of Map Units for detailed descriptions). A query (?) at the top and (or) bottom of a unit box indicates that the upper and (or) lower chronologic position(s) of the unit is (are) not precisely constrained 232±5 CE tpf Surficial Deposits ≺ Huka Group ≺ **OUATERNARY**

CORRELATION OF MAP UNITS

Reporoa Group

Figure 2. Colored shaded-relief map of the central part of the North Island of New Zealand. The solid red line represents the approximate location of the Taupo Volcanic Zone boundary (after Wilson and others 1995, 2009). The dashed black lines represent approximate caldera and (or) volcanic center boundaries (after Wilson and others, 2009). The solid white line outlines the map area. Volcanic feature abbreviations: KCC, Kapenga Caldera Complex; MaC, Mangakino Caldera; OhC, Ohakuri Caldera; OVC, Okataina Volcanic Center; PFB, Paeroa Fault block; ReC, Reporoa Caldera; RoC, Rotorua Caldera; TFB, Taupo Fault Belt; TRB, Taupo-Reporoa Basin; TVC, Taupo Volcanic Center; TVZ, Taupo Volcanic Zone; TWFB, Te Weta Fault block WhC, Whakamaru Caldera. The Coromandel Volcanic Zone, Kiwitahi Volcanics, and Hauraki Rift are

pre-Taupo Volcanic Zone surface manifestations of arc-related volcanic and tectonic processes.

Base from Land Information New Zealand, 1:50,000: BF36

Universal Transverse Mercator projection, Zone 60S,

Atiamuri, 2018; BF37 Waiotapu, 2018

APPROXIMATE MEAN DECLINATION, 2020 **CONTOUR INTERVAL 20 METERS** MAP LOCATION

Geologic Map of the Paeroa Fault Block and Surrounding Area, **Taupo Volcanic Zone, New Zealand**

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DESCRIPTION OF MAP UNITS

[Note that each unit is labeled on the map. Map units are divided into surficial deposits, Huka Group Whakamaru Group and its accompanying Paeroa Subgroup, and Reporoa Group. Units for surficial deposits and each group (and subgroup) are listed from youngest to oldest. Unit names from Leonard and others (2010) are used where possible, and informal names are used elsewhere. Undifferentiated middle Pleistocene ignimbrites and air-fall tephras interbedded with paleosols and alluvium are labeled **Qvo** (Quaternary volcanics). References and age-dating methods for units are given with the most up-to-date ages used. Any age lacking a reference is being reported here for the first time. Unless otherwise stated, all ages are reported at one-sigma error]

SURFICIAL DEPOSITS

Colluvium (Holocene to middle Pleistocene)—Landslide and rockfall deposits composed of sand-, gravel-, and boulder-size (to 10 m diameter) volcaniclastic sediments. This unit is exposed adjacent to the topographically highest parts of the Paeroa Fault block and consists of remobilized Paeroa Subgroup (paf, tkf, twf, 339±2 ka), waf (710±60 ka), whg (349±2 ka), and other lithologies along the northwest and southeast margins of Reporoa Caldera. Landslides and rockfalls are an ongoing process inferred to have initiated during the middle Pleistocene soon after uplift of the Paeroa Fault block

tpa Taupo Pumice Alluvium (Holocene)—Alluvial deposits formed during erosion and redeposition of unit tpf (232±5 CE; Manville,2001). This unit is primarily exposed in the southern part of the map area along the Waikato River but also as patches throughout low-lying parts of the map area and reaches tens of meters thick. It predominantly consists of laminated to cross-bedded sands and gravels to fine-grained lacustrine sediments. Overlies units dma (183±9 ka), eff, hga, ohf (246±5 ka), Qvo, rh3, rt8 (490±3 ka), tga, tpf (232±5 CE), and whg (349±2 ka)

tpf Taupo Pumice Formation (Holocene)—Caldera-related ignimbrite (~30 km³) that was associated with caldera collapse at the Taupo Volcanic Center (Wilson, 1985, 1993). This unit is exposed throughout the map area as a thin (<1 m thick) veneer over topographically high areas within the Paeroa and Te Weta Fault blocks but is only displayed on the map in low-lying areas of the Paeroa Fault zone, Waikato River, and Taupo-Reporoa Basin (including Reporoa Caldera), where it reaches tens of meters thick. The ignimbrite is pale gray to brown and unwelded and consists of sand- to silt-size ash with zones of concentrated juvenile pumice and (or) lithic clasts. Juvenile pumice clasts are rhyolitic, white to pink, low density, and crystal poor (≤5%) with phenocrysts of plagioclase, orthopyroxene, and Fe-Ti oxides. Carbonized vegetation, including large logs, is common throughout this unit. Lithic clasts mostly consist of rhyolitic lavas and ignimbrites. It is the youngest primary volcanic unit in the map area and overlies all other geologic deposits, except for unit tpa. ¹⁴C age (at

two-sigma errors) on plant matter: 232±5 CE (Hogg and others, 2012) tag Taupo Group (Holocene to late Pleistocene)—Diverse assemblage of crystal-poor to crystal-rich, rhyolitic ignimbrites and air-fall tephras that erupted from the Taupo Volcanic Center and the paleosols interbedded with these explosive volcanic deposits (see Wilson [1993] and Wilson and others [2009] for full details and ages of individual volcanic products that make up this unit). These deposits are either too small and (or) thin to be depicted individually at the map scale and, therefore, are shown as a single unit (after Leonard and others, 2010). This unit is exposed along the downthrown part of the Paeroa Fault zone where topographic lows have allowed these deposits to accumulate to thicknesses of several meters. Overlies units kaf (299±3 ka), ohf (246±5 ka), and paf (339±2 ka); underlies unit tpf (232±5 CE); interbedded with unit col. The most widespread and voluminous (~530 km³) product of this group is the caldera-related Oruanui Formation that accompanied caldera collapse in the Taupo Volcanic Center at 25.4±0.2 ka (Wilson, 2001; ¹⁴C age [at two-sigma errors] on plant matter from Vandergoes and others, 2013)

Taupo Group Alluvium (late Pleistocene)—Extensive alluvial deposits formed by erosion and redeposition of primary volcanic products of unit tag. The most extensive of these sediments encompassed by this unit are termed the Hinuera Formation, which are reworked from the 25.4±0.2 ka Oruanui Formation (part of unit tag) during the last glacial maximum (Manville and Wilson, 2004). This unit is exposed throughout the Taupo-Reporoa Basin, particularly near the margins of Reporoa Caldera and the northern Paeroa and Te Weta Fault blocks, with deposits reaching tens of meters thick. The alluvium is unconsolidated, laminated to cross-bedded, and contains sand- and gravel-sized pumice, ignimbrite, lava, and crystal fragments. Overlies units eff, hga, kaf (299±3 ka), maf (322±7 ka), mpf (246±5 ka), ohf (246±5 ka), paf (339±2 ka), Qvo, rka (247±2 ka), rmi (281±9 and 239±3 ka), rpu (263±5 ka), rt8 (490 \pm 3 ka), waf (710 \pm 60 ka), and whg (349 \pm 2 ka); underlies units tpa and tpf (232 \pm 5 CE)

Akatarewa Basalt Formation (late Pleistocene)—Small-volume (<0.1 km³) phreatomagmatic basaltic scoria and breccia, locally sourced within the southern Paeroa Fault block. This unit is exposed as two patches near the Paeroa Fault zone and is <10 m thick. It is brown, unwelded, and massive to well bedded and has a fine-ash matrix. Juvenile clasts are basalt and include vesicular scoria and dense lava that are \leq 5 cm diameter. Lithic clasts are \leq 7 cm diameter and include silicified rhyolitic ignimbrite and fine-grained lacustrine sediments. Overlies unit ohf (246±5 ka); underlies unit tpf (232±5 CE). Undated, but stratigraphically bracketed by rhyolitic air-fall tephras with ages of ~45 and 30 ka (Leonard and others, 2010)

HUKA GROUP

eff Earthquake Flat Formation (late Pleistocene)—Moderate-volume (~7 km³) ignimbrite and coeval air-fall tephra erupted from the Kapenga Caldera Complex (Wilson and others, 2009). This unit is exposed in the northern part of the map area and reaches ~10 m thick. The ignimbrite is white and unwelded and has a crystal-rich (20–40%) matrix. Juvenile pumice clasts are rhyolitic, white, and crystal rich (23–35%) with phenocrysts of plagioclase, quartz, orthopyroxene, hornblende, biotite, and Fe-Ti oxides. Overlies units dma (183±9 ka), kaf (299±3 ka), paf (339±2 ka), Qvo, tkf (339±2 ka), and whg (349±2 ka); underlies units tga, tpa, and tpf (232±5 CE). Undated, however stratigraphic arguments indicate that it is the same age as the Rotoiti Formation in the northern segment of the Taupo Volcanic Zone (TVZ; Wilson and others, 1995, 2009), which has a combined ²³⁸U/²³⁰Th and (U–Th)/He age on zircon of 45.1±3.3 ka and a ¹⁴C age on plant matter of 44.8±0.3 ka (Danišík and others, 2012)

rh3 Rhyolite of Hill 353 (middle Pleistocene)—Rhyolitic lava dome within the southern part of the map area. Only the eastern part of this unit is located inside the map area, whereas the western half of the dome is west of the Waikato River. The lava dome is dense and crystal moderate (10–15%) with phenocrysts of plagioclase, quartz, hornblende, biotite, and Fe-Ti oxides. Underlies units tpa and tpf (232±5 CE). Undated

Huka Group Alluvium (middle Pleistocene)—Fine- to coarse-grained sediments of lacustrine and fluvial origin exposed throughout the map area, but most prevalent in the southern Paeroa Fault block, northwestern Te Weta Fault block, and a few patches in the northern Paeroa Fault block and Reporoa Caldera. This unit consists of millimeter- to centimeter-scale-laminated, fine-grained sediments that are unconsolidated or loosely compacted but locally silicified and zeolitized. Laminations range from parallel to low-angle cross-bedded and consist of clay- to sand-size fragments of ash, fine pumiceous sediments, crystals, and diatoms. Some laminations are pumice-clast supported and reverse graded, containing well-rounded pumice clasts of <3 cm diameter. Soft-sediment-deformation structures are common and include water-escape</p> cusps, ball and pillow structures, detached pseudonodules, mushroom structures, and flame structures (Downs, 2016). Evidence of brittle failure, in the form of normal faults, is common where sediments are more compact and (or) silicified or zeolitized. Several locations within the southern Paeroa Fault block have deposits of fine to coarse, cross-bedded sand containing abundant imbricated gravels and pebbles. These sediments represent fluvial deposits that gradually grade into overlying and underlying lacustrine sediments everywhere they have been observed. Fluvial deposits contain clasts of Mesozoic metasedimentary rocks, lavas, and rhyolitic ignimbrites. Overlies units ama and paf (339±2 ka); underlies units maf (322±7 ka), tga, tpa, and tpf (232±5 CE); interbedded with units hbp, kaf (299±3 ka), ohf (246±5 ka), Qvo, and rmi (281±9 and 239±3 ka). Sediments that make up this unit were deposited after emplacement of the Paeroa Subgroup (paf, tkf, twf, 339±2 ka) and encompass a large time interval as shown by their intercalation with primary volcanic deposits with, and following,

emplacement of the youngest rmi (239±3 ka) ignimbrite **Dacite of Maungaonga (middle Pleistocene)**—Dacitic lava dome (~1 km³) within the northern Paeroa Fault block. Contains phenocrysts of plagioclase, orthopyroxene, and Fe-Ti oxides. Overlies unit Qvo; underlies units eff, tga, and tpa. 40K/40Ar age on groundmass:

183±9 ka (Wilson and others, 1995) Qvo Quaternary volcanics (middle Pleistocene)—This unit encompasses undivided ignimbrites and air-fall tephras interbedded with paleosols and alluvium. In the northern Paeroa Fault block, these deposits have previously been called Onuku Breccia (Nairn, 2002) and Maroa Group (Leonard and others, 2010). Very few descriptions and (or) age constraints exist for this unit. ⁴⁰Ar/³⁹Ar age on plagioclase: 312±4 ka from a lag breccia (Downs and others, 2014a) in this unit in the southeastern Paeroa Fault block, however this unit is presumed to span a large time interval during the middle Pleistocene

Rhyolite of Mihi (middle Pleistocene)—Subaqueously erupted ignimbrites, locally sourced from the southern Paeroa Fault block and Reporoa Caldera, interbedded with lacustrine and fluvial sediments of unit hga (Downs and others, 2014a; Downs, 2016). Proposed to be related to similar-aged rhyolitic lava domes of units rdh (265±4 ka), rka (247±2 ka), rpu (263±5 ka), and inferred buried post-kaf (299±3 ka) rhyolitic lava domes within Reporoa Caldera. This unit is exposed throughout the southern Paeroa Fault block, and generally is tens of meters thick. The ignimbrites are unwelded, but locally silicified and (or) case hardened, massive to diffusely bedded, and moderately sorted and contain variable amounts of pumice, lithics, and crystal fragments in fine-ash matrixes, with rare pumice clast-supported zones. Clastic dikes and soft-sediment deformation features composed of fine-ash and (or) pumiceous clasts are posed locally. Juvenile clasts are rhyolitic and include both low-density, fibrous pumice ar dense, massive lava that reach < 1.6 m diameter, but are more commonly < 5 cm diameter, are prismatically jointed at their margins, and are crystal poor (5–10%) with phenocrysts of plagioclase, quartz, minor orthopyroxene, and Fe-Ti oxides. Lithic clasts are almost exclusively massive to laminated, fine-grained lacustrine sediments from unit hga. Most lithic clasts are unconsolidated, <1 m diameter, and are most prevalent at the base of ignimbrites and decrease in abundance stratigraphically upwards. Overlies, underlies, and interbedded with unit hga; overlies units ama, hbp, kaf (299±3 ka), and ohf (246±5 ka); underlies units tga and tpf

(232±5 CE). ⁴⁰Ar/³⁹Ar ages on plagioclase: 281±9 and 239±3 ka (Downs and others, 2014a) **Hydrothermal breccia of Pukemoremore (middle Pleistocene)**—Small-volume (<1 km³) hydrothermal eruption breccia, locally sourced within the southern Paeroa Fault block. This unit is exposed as three small patches and is <10 m thick. The breccia is clast supported. poorly sorted, and contains boulders and cobbles of ≤2 m diameter in a sand to clay matrix. Clasts are generally silicified and include fine-grained lacustrine sediments, rhyolitic ignimbrites, and sparse sinter. The lack of juvenile clasts argues for a nonmagmatic origin, and the clast-supported, poorly-sorted nature and presence of sinter are used to interpret a hydrothermal eruption breccia origin. Underlies unit rmi (281±9 and 239±3 ka). Undated, but its stratigraphic position indicates a middle Pleistocene age

Ohakuri Formation (middle Pleistocene)—Caldera-related ignimbrite and coeval air-fall tephra (~100 km³) that accompanied collapse of Ohakuri Caldera (Gravley and others, 2007). This unit crops out within the southern Paeroa Fault block, where ~200-m thickness is exposed due to uplift along the Paeroa Fault scarp. It is tens of meters thick elsewhere in the southern Paeroa Fault block and northwestern Te Weta Fault block. It encompasses several lithofacies, of which the main two are a massive, structureless lithofacies and a large-scale, cross-bedded lithofacies with wavelengths of the bedforms sometimes exceeding ~50 m. The ignimbrite is cream, tan, and (or) light gray, unwelded but locally silicified and (or) case hardened, and locally accretionary lapilli bearing and has an ash-rich matrix. Juvenile pumice clasts are dominantly rhyolitic, sparsely dacitic, and very rarely andesitic and fall into three groups. The first is white to light gray, low-density, fibrous textured, and crystal poor (\leq 5%). The second is dark gray, moderately dense, and crystal moderate (10–15%). The third is rare and of andesitic composition (Gravley and others, 2007). Most juvenile pumice clasts contain phenocrysts of plagioclase, quartz, orthopyroxene, and Fe-Ti oxides. Sparse pumice clasts contain mafic glomeroporphyritic clots to <1 cm diameter of cumulate crystals, which are identical to common plutonic clasts in parts of this unit. The plutonic clasts are coarse- and fine-grained dolerites, microdiorites, and granitoids. Dolerite and microdiorite clasts consist of plagioclase, hornblende surrounding clinopyroxene cores, rare orthopyroxene, apatite, and minor glass. Granitoid clasts consist of plagioclase, quartz, biotite, and minor clinopyroxene. The presence of dolerite and microdiorite fragments within juvenile pumices argues for a mafic cumulate source related to the unit ohf magmatic system. Lithic clasts are locally abundant and include basaltic andesite, andesitic, dacitic, and rhyolitic lavas; obsidian; crystal-poor ignimbrites; and fine-grained lacustrine sediments. A clast-supported lithic-lag breccia with clasts >1 m diameter is located along the Paeroa Fault scarp. Overlies units ama, kaf (299±3 ka), paf (339±2 ka), tkf (339±2 ka), and twf (339±2 ka); underlies units abf, hga, maf (322±7 ka), mpf (246±5 ka), rmi (281±9 and 239±3 ka), tag, tga, tpa, and tpf (232±5 CE). Undated, however stratigraphic arguments in Gravley and others (2007) indicate

this unit has the same age as unit mpf (246±5 ka)

HUKA GROUP (CONTINUED)

Mamaku Plateau Formation (middle Pleistocene)—Caldera-related ignimbrite and coeval air-fall tephra (~145 km³) that accompanied collapse of Rotorua Caldera (Milner and others, 2002, 2003). This unit is exposed as a single outcrop within the northern Te Weta Fault block and is tens of meters thick. The ignimbrite is pink, purple, and (or) gray, sintered to moderately welded, locally columnar jointed, and vapor-phase altered. Juvenile pumice clasts are dacitic to rhyolitic, generally powdery due to vapor-phase alteration, and crystal moderate (10–15%) with phenocrysts of plagioclase, quartz, altered orthopyroxene, and Fe-Ti oxides. Lithic clasts include rhyolitic lavas and ignimbrites. Underlies units ohf $(246\pm5 \text{ ka})$, tga, and tpf $(232\pm5 \text{ CE})$. $^{40}\text{Ar}/^{39}\text{Ar}$ ages on plagioclase: $240\pm11 \text{ ka}$ (Gravley and others, 2007) and 248±6 ka (this map), with a weighted mean of 246±5 ka used for the

Rhyolite of Kairuru (middle Pleistocene)—Post-kaf (299±3 ka) rhyolitic lava dome situated along the west edge of Reporoa Caldera (Nairn and others, 1994; Beresford and others, 2000; Downs and others, 2014a). The lava dome is dense, perlitic to flow banded, and crystal poor (\leq 10%) with phenocrysts of plagioclase, quartz, rare orthopyroxene, and Fe-Ti oxides. Underlies units tga and tpf (232±5 CE). ⁴⁰Ar/³⁹Ar age on plagioclase: 247±2 ka (Downs and others, 2014a)

Rhyolite of Pukekahu (middle Pleistocene)—Post-kaf (299±3 ka) rhyolitic lava dome in the middle of the Reporoa Caldera (Nairn and others, 1994; Beresford and others, 2000; Downs and others, 2014a). The lava dome is dense, perlitic to weakly flow banded, and crystal poor (≤2%) with phenocrysts of plagioclase, orthopyroxene, and Fe-Ti oxides. Underlies unit tga. ⁴⁰Ar/³⁹Ar age on plagioclase: 263±5 ka (Downs and others, 2014a) Rhyolite of Deer Hill (middle Pleistocene)—Post-kaf (299±3 ka) rhyolitic lava dome situated on

the south edge of Reporoa Caldera (Nairn and others, 1994; Beresford and others, 2000; Downs and others, 2014a). The lava dome is dense, perlitic to flow banded, and crystal poor (≤5%) with phenocrysts of plagioclase, orthopyroxene, and Fe-Ti oxides. Underlies unit tpf $(232\pm5 \text{ CE})$. ${}^{40}\text{Ar}/{}^{39}\text{Ar}$ ages on plagioclase: $264\pm4 \text{ ka}$ (Downs and others, 2014a) and 295 ± 19 ka (this map), with a weighted mean of 265±4 ka used for the eruption age

Kaingaroa Formation (middle Pleistocene)—Caldera-related ignimbrite and coeval air-fall tephra (~100 km³) that accompanied collapse of Reporoa Caldera (Nairn and others, 1994; Beresford and Cole, 2000; Beresford and others, 2000; Downs and others, 2014a). This unit is exposed throughout the uplifted southern Paeroa and Te Weta Fault blocks and in two patches in the northern Paeroa Fault block, reaching ~100 m thickness but generally only tens of meters thick. It consists of a basal air-fall tephra with abundant accretionary lapilli overlain by four ignimbrite sheets. Each ignimbrite sheet is distinguishable by color. The lowest ignimbrite sheet is yellow-brown, followed by a black-gray ignimbrite sheet, then a pink-red ignimbrite sheet, and, finally, the highest ignimbrite sheet is tan-brown and contains clasts of prior unit kaf ignimbrite sheets. Overall, the formation ranges from unwelded to strongly welded, columnar jointed, and vapor-phase altered in its middle and upper parts and has a crystal-poor (5%) matrix that is vitric to devitrified. Juvenile pumice clasts are dacitic to rhyolitic, white to orange, and crystal poor (\leq 5%) with phenocrysts of plagioclase, quartz, orthopyroxene, and Fe-Ti oxides. Lithic clasts include basaltic andesite, andesitic, dacitic, and rhyolitic lavas; fine-grained lacustrine clasts; crystal-rich and crystal-poor rhyolitic ignimbrites; and rare plutonic clasts. Coignimbrite lithic lag breccias are present near the source of this unit along the margins of Reporoa Caldera, with lithic-rich zones containing clasts >2 m diameter that decrease in size away from the caldera. Overlies units paf (339±2) ka), Qvo, and twf (339±2 ka); underlies units eff, ohf (246±5 ka), rmi (281±9 and 239±3 ka), tag, tga, and tpf (232±5 CE); interbedded with unit hga. ⁴⁰Ar/³⁹Ar ages on plagioclase: 298±3 ka (Downs and others, 2014a) and 324±17 ka (this map), with a weighted mean of 299±3 ka used for the eruption age

Andesite of Mangamingi (middle Pleistocene)—Small-volume (<1 km³) phreatomagmatic andesitic breccia and ash, locally sourced within the southern Paeroa Fault block (Downs and others, 2014a). This unit is exposed as five small patches, some reaching ~40 m thick. Exposures are brown to black, unwelded, moderately consolidated, locally silicified, diffusely to well bedded, and clast supported to fine-ash-matrix supported. Juvenile clasts include scoria and dense lava of basaltic andesite to andesite, ≤15 cm diameter, and aphyric. Sparse juvenile dacitic pumice clasts are ≤10 cm diameter and crystal moderate (10–15%) with phenocrysts of plagioclase, quartz, hornblende, biotite, and Fe-Ti oxides. Lithic clasts are sparse and include rhyolitic ignimbrites and fine-grained lacustrine sediments. Underlies units hga, ohf (246±5 ka), rmi (281±9 and 239±3 ka), and tpf (232±5

Matahina Formation (middle Pleistocene)—Caldera-related ignimbrite and coeval air-fall tephra (~150 km³) that erupted from the Okataina Volcanic Center (Bailey and Carr, 1994; Cole and others, 2014). This unit is exposed as two patches that reach tens of meters thick; one in the northern Paeroa Fault block and the other in the northern Te Weta Fault block. The ignimbrite is tan-pink to brown, unwelded to strongly welded, columnar jointed and locally eutaxitic and shows minor vapor-phase alteration. Juvenile pumice clasts are rhyolitic, ≤7 cm diameter, and crystal poor to crystal moderate (≤15%) with phenocrysts of plagioclase, quartz, orthopyroxene, hornblende, and Fe-Ti oxides. Lithic clasts are common, ≤5 cm diameter, and include rhyolitic lavas, crystal-rich ignimbrites, silicified fine-grained clasts, and black vitrophyre clasts with bread-crusted margins (Bailey and Carr, 1994). Overlies units hga and paf (339±2 ka); underlies units ohf (246±5 ka), Qvo, tga, and tpf (232±5 CE). ⁴⁰Ar/³⁹Ar age on plagioclase: 322±7 ka (Leonard and others,

WHAKAMARU GROUP

Whakamaru Group (middle Pleistocene)—Caldera-related ignimbrites and coeval air-fall tephra (>2,500 km³) that accompanied formation of Whakamaru Caldera (Houghton and others, 1995; Wilson and others, 1995, 2009). This group consists of seven ignimbrites, the first four of which are assigned to unit whg (349±2 ka). The subsequent three ignimbrites are assigned to the later erupted Paeroa Subgroup (units paf, tkf, twf, 339±2 ka). Most of unit whg, as assigned here, is restricted to the east and west margins of the TVZ, and only three patches along the east part of our map area are shown. Each ignimbrite can reach >100 m thick and crops out as cliffs and slopes of gray to brown tuff that is unwelded to strongly welded, is jointed where strongly welded, vapor-phase-altered in its upper part, and has a crystal-rich (≤50%) matrix. Juvenile pumice clasts are rhyolitic and crystal rich (20–50%) with phenocrysts of plagioclase, sanidine, quartz, orthopyroxene, hornblende, biotite, and Fe-Ti oxides. Plagioclase and quartz reach ~1 cm diameter and are embayed, resorbed, or bipyramidal. Lithic clasts include Mesozoic metasediments, andesitic and rhyolitic lavas, and ignimbrites. Underlies units eff, Qvo, tga, tpa, and tpf (232±5 CE). ⁴⁰Ar/³⁹Ar ages on plagioclase: 350±3 ka, 349±3 ka, and 347±4 ka, with a weighted mean of 349±2 ka accepted as the eruption age (Downs and others, 2014b)

PAEROA SUBGROUP

Paeroa Formation (middle Pleistocene)—Caldera-related ignimbrite (~50 km³) erupted from the Paeroa linear vent zone (Downs and others, 2014b). This unit is exposed in the highest parts of the Paeroa and Te Weta Fault blocks and reaches ~140 m thick along the Paeroa Fault scarp. The ignimbrite is light gray, unwelded to moderately welded, locally eutaxitic, and has a crystal-rich (20–50%) matrix. Juvenile pumice clasts are rhyolitic, white to gray, <10 cm diameter, and crystal rich (30–35%) with phenocrysts of plagioclase, sanidine, quartz, orthopyroxene, hornblende, biotite, and Fe-Ti oxides. Plagioclase and quartz are typically 5–10 mm diameter and embayed, resorbed, or bipyramidal. Lithic clasts are as much as ~4 m diameter in coignimbrite lag breccias, but most lithic clasts are a few centimeters in diameter and include fine-grained volcaniclastic sediments, andesitic and rhyolitic lavas, and crystal-rich andesitic and rhyolitic ignimbrites. Overlies units tkf (339±2 ka), twf (339±2 ka), and waf (710±60 ka); underlies units col, eff, hga, kaf (299±3 ka), maf (322±7 ka), ohf $(246\pm5 \text{ ka})$, Qvo, tag, tga, and tpf $(232\pm5 \text{ CE})$. $^{40}\text{Ar}/^{39}\text{Ar}$ age on plagioclase: $341\pm3 \text{ ka}$, a weighted mean of 339±2 ka (using the ages of paf and tkf based on stratigraphic arguments)

is accepted as the eruption age (Downs and others, 2014b) **Te Weta Formation (middle Pleistocene)**—Caldera-related ignimbrite erupted from the Paeroa linear vent zone (Downs and others, 2014b). This unit is exposed within the Paeroa and Te Weta Fault blocks, ranging from 110–240 m thick along the central part of the Paeroa Fault scarp. Forming tan to gray cliffs, the ignimbrite is unwelded to moderately welded, locally case hardened, locally accretionary lapilli bearing, and vapor-phase altered and has a crystal-rich (20–50%) matrix. Juvenile pumice clasts are rhyolitic, white to gray, ≤10 cm diameter, and crystal rich (25–35%) with phenocrysts of plagioclase, sanidine, quartz, orthopyroxene, hornblende, biotite, clinopyroxene, and Fe-Ti oxides. Plagioclase and quartz are typically 5–10 mm diameter and embayed, resorbed, or bipyramidal. Lithic clasts reach ~1.5 m diameter in coignimbrite lithic lag breccias, but most are a few centimeters in diameter and include fine-grained volcaniclastic sediments and crystal-rich rhyolitic ignimbrites. Overlies unit tkf (339±2 ka); underlies units kaf (299±3 ka), ohf (246±5 ka), paf

(339±2 ka), and tpf (232±5 CE). Undated, a weighted mean of 339±2 ka (using the ages of

paf and tkf based on stratigraphic arguments) is accepted as the eruption age (Downs and Te Kopia Formation (middle Pleistocene)—Caldera-related ignimbrite (~60 km³) erupted from the Paeroa linear vent zone (Downs and others, 2014b). This unit is exposed in the Paeroa Fault block at the base of the Paeroa Fault scarp, reaching ~120 m thick, and as a patch in an incised valley near the east side of the Paeroa Fault block. Forming gray-black to brown cliffs, the ignimbrite is unwelded to strongly welded, columnar jointed, and eutaxitic and has minor vapor-phase alteration, rare low-angle cross-bedding, and a crystal-rich (20–50%) matrix. Juvenile pumice clasts are rhyolitic, elongate (aspect ratio of 10:1), and crystal rich (25–40%) with phenocrysts of plagioclase, sanidine, quartz, orthopyroxene, hornblende, biotite, clinopyroxene, and Fe-Ti oxides. Plagioclase and quartz are typically 5–10 mm diameter and embayed, resorbed, or bipyramidal. Lithic clasts are up to ~4 m diameter in coignimbrite lithic lag breccias, but most lithic clasts are a few centimeters in diameter and include fine-grained volcaniclastic sediments, mafic scoria, rhyolitic lavas, and crystal-poor to crystal-rich rhyolitic ignimbrites. Underlies units col, eff, ohf (246±5 ka), paf (339±2 ka), and twf (339±2 ka). ⁴⁰Ar/³⁹Ar age on plagioclase: 335±4 ka, a weighted mean of 339±2 ka

(using the ages of paf and tkf based on stratigraphic arguments) is accepted as the eruption

age (Downs and others, 2014b) **REPOROA GROUP**

Rhyolite of Trig 8566 (middle Pleistocene)—Rhyolitic lava dome (~0.5 km³) exposed within the northeast Paeroa Fault block, with the southern part of the dome missing due to collapse into Reporoa Caldera. This lava dome is >40 m thick, massive, and crystal rich (25%) with phenocrysts of plagioclase, quartz, orthopyroxene, hornblende, biotite, and Fe-Ti oxides. Overlies unit waf (710±60 ka); underlies units Qvo, tga, tpa, and tpf (232±5 CE). 40Ar/39Ar age on plagioclase: 490±3 ka (Downs and others, 2014a)

Waiotapu Formation (middle Pleistocene)—Caldera-related ignimbrite (~100 km³) erupted from somewhere in the vicinity of Waiotapu. This unit is exposed within the northeastern Paeroa Fault block, where it is ~100 m thick but reaches ~400 m thick in the subsurface ~2 km to the east near Waiotapu (Steiner, 1963). Forming gray-brown to purple cliffs and slopes, the ignimbrite is strongly welded, eutaxitic, and devitrified and contains abundant gas-exolution features and has subhorizontal cooling joints and a crystal-poor to crystal-moderate (5–15%) matrix. Juvenile pumice clasts are dacitic to rhyolitic, white, elongate (aspect ratio of 10:1), and crystal poor (5%) with phenocrysts of plagioclase, orthopyroxene, and Fe-Ti oxides. Lithic clasts are <5 cm diameter and include andesitic and rhyolitic lavas and crystal-rich ignimbrites. Overlies unit rng (965±8 ka); underlies units col, paf (339±2 ka), Qvo, and tga. ⁴⁰Ar/³⁹Ar age on plagioclase: 710±60 ka (Houghton and others, 1995)

Rhyolite of Ngapouri (early Pleistocene)—Rhyolitic lava dome partially exposed along the Ngapouri Fault zone within the northeast Paeroa Fault block. This lava dome is >20 m thick, flow banded, fractured, devitrified, and crystal poor (5–10%) with phenocrysts of quartz, plagioclase, altered hornblende and orthopyroxene, and Fe-Ti oxides. Underlies units Qvo and waf (710±60 ka). ⁴⁰Ar/³⁹Ar age on plagioclase: 965±8 ka (Downs and others, 2014a)

EXPLANATION OF MAP SYMBOLS

Contact—Approximately located

Fault—Approximately located. Bar and ball on downdropped block **Roads**—Both paved and unpaved

⊥ — **⊥** Reporoa Caldera boundary—Hachures are on collapsed block

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